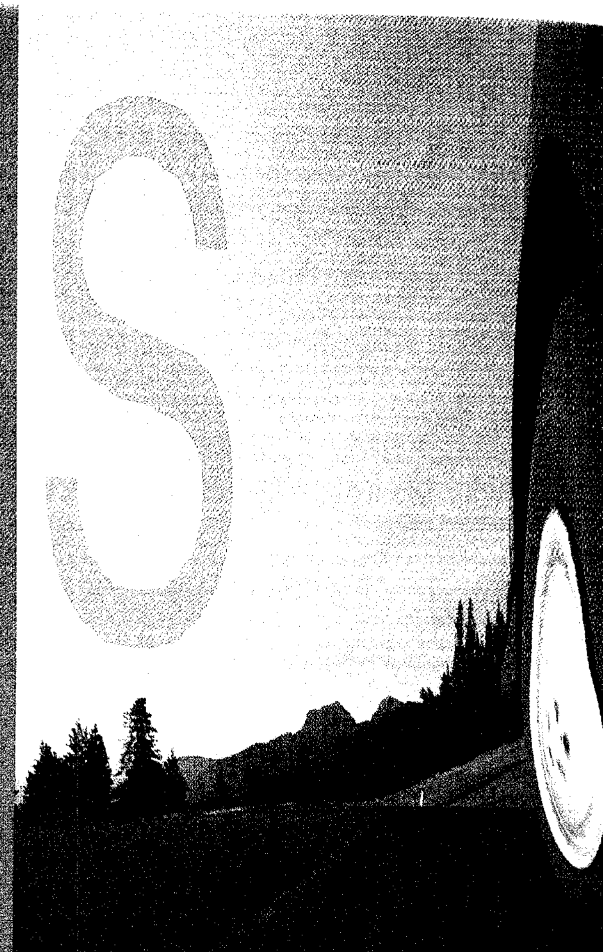
SAVING LIVES

THROUGH ADVANCED SAFETY TECHNOLOGY



Intelligent Vehicle Initiative

2002 ANNUAL REPORT

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Looking Down the Road

IVI Program Overview

This Annual Report provides an overview of the Intelligent Vehicle Initiative's (IVI's) progress and accomplishments during 2002. The 1998 Transportation Efficiency Act for the 21 st Century (TEA-21) authorized IVI as part of the Department of Transportation's (DOT's) Intelligent Transportation Systems (ITS) program.

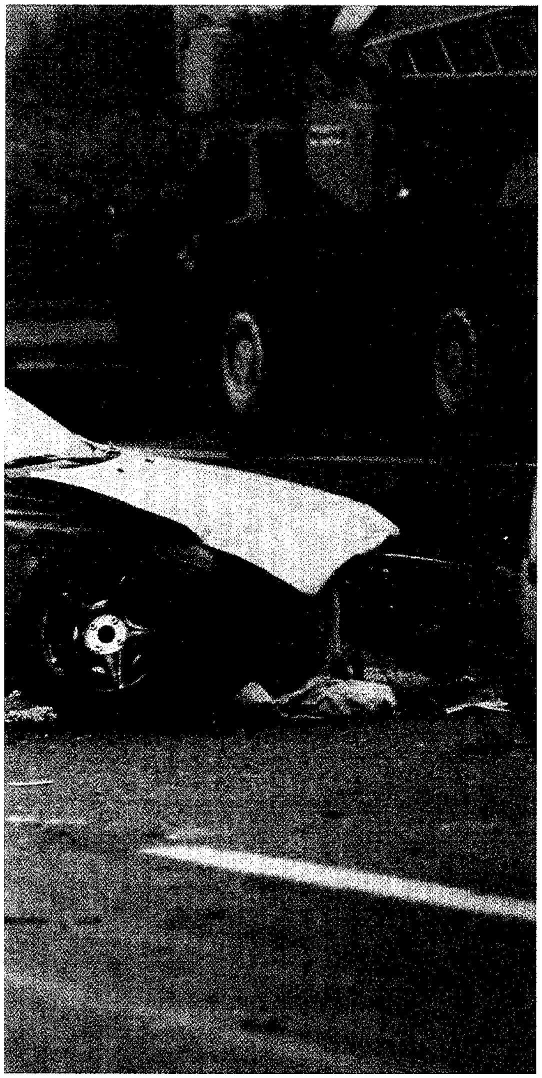
IVI's Mission: Prevention of Highway Crashes and the Fatalities and Injuries They Cause

More than 42,000 Americans died as a result of 6.8 million crashes on our Nation's roadways last year. On average, a person was injured in one of these crashes every 10 seconds, and someone was killed every 12 minutes.

While the magnitude of the highway death toll is shocking, the impact of highway injuries is even more far-reaching. Traffic crashes injured more than 3 million Americans in 2001 (the latest year for which statistics are available). Crash survivors often sustain multiple injuries and require long hospitalizations. Crashes cost society more than $230 billion a year and consume a greater share of the Nation's health care costs than any other cause of illness or injury.

In 2001, the fatality rate per 100 million vehicle miles of travel reached a new historic low of 1.51. DOT programs to promote vehicle safety improvements and fundamental changes in driver behavior have saved more than 250,000 lives and $700 billion over the last four decades. Widespread use of safety belts and airbags has greatly improved the survival rate of crash victims.

Crashes cost society more than $230 billion a year and consume a greater share of the Nation's health care costs than any other cause of illness or injury.



Yet, as the statistics show, reduction of highway fatalities and injuries remains an urgent public health concern. Demographic trends point toward an increasingly hazardous driving environment, making it clear that new safety interventions must be developed if we are to continue to make progress. Significant forecast population growth will bring even more vehicles and drivers to our already-congested highways. The population of the youngest drivers, ages 16 to 24—those most likely to be involved in traffic crashes-will increase by 19 percent by 2020.

Because driver error remains the leading cause of crashes, cited in more than 90 percent of police crash reports, the IVI's mission is to reduce the number and severity of crashes through driver assistance programs. These safety systems, now in various stages of development, will provide information, warn drivers of dangerous situations, recommend actions, and even assume partial control of vehicles to avoid collisions.

Prevention: A New Direction for DOT Safety Programs

IVI's focus is to prevent crashes by helping drivers to avoid hazardous mistakes. This is a significant new direction for DOT safety programs, which, in the past, have focused on crash mitigation (that is, alleviation of the severity of crash-related injury to persons and property).

The objectives of DOT's IVI activities are:

- Preventing driver distraction, and
- Facilitating accelerated development and deployment of crash-avoidance systems.

Preventing Driver Distraction

Through the IVI, DOT is working to prevent driver distraction by ensuring the safety (under normal conditions) of in-vehicle information and communication systems such as:

- Cellular telephones;
- In-vehicle computers;
- Route guidance and navigation systems; and
- Adaptive cruise control.

IVI research is exploring the implications of in-vehicle tech-

4 VEHICLE PLATFORMS

The IVI addresses four classes or "platforms" of vehicles. Various types of crash avoidance technologies are being tested in the four vehicle platforms. In most cases, lessons learned about the effectiveness of various crash avoidance technologies will transfer across platforms.

By analyzing the unique problems that each type of vehicle encounters in its typical driving environment, the results of IVI research and field tests will help vehicle manufacturers decide which driver assistance systems should be installed in each type of vehicle.

LIGHT VEHICLES

Passenger vehicles, light trucks, vans, and sport utility vehicles (SUVs)

COMMERCIAL VEHICLES

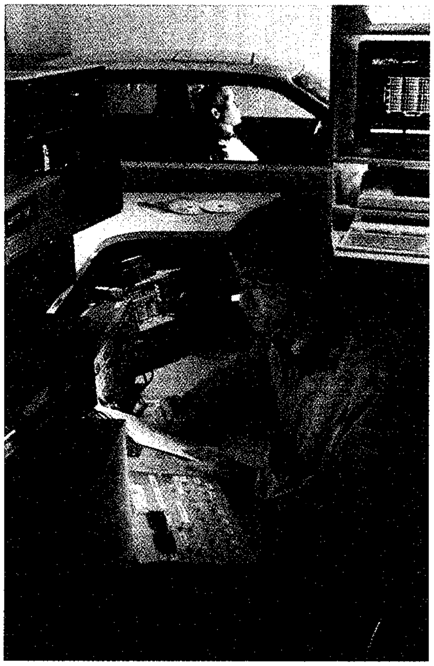
Heavy trucks and Interstate buses

TRANSIT VEHICLES

Non-rail vehicles operated by transit agencies

SPECIALTY VEHICLES

Emergency response, enforcement, and highway maintenance vehicles



nologies on driver behavior. Objectives are to:

- Improve understanding of the nature and extent of the driver distraction safety problem;
- Develop and apply methods to measure the effects of technology and driver characteristics on driving performance;
- Develop human factors guidelines to aid in equipment design; and
- Develop integrated approaches to reduce the distraction caused by in-vehicle devices.

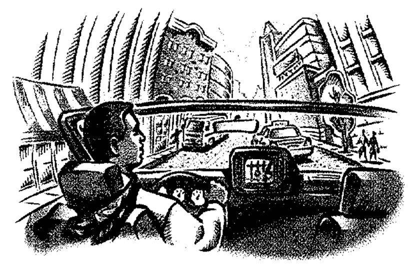
Facilitating Accelerated Development and Deployment of Crash Avoidance Systems

The vehicle and highway industries, and local governments play the leading roles in the development and deployment of crash avoidance systems. Through the IVI, the Federal government is helping industry to produce better safety systems more

IVI is Improving Safety Under Three Driving Conditions

Based on an analysis of crash statistics, the IVI addresses three driving conditions where there is the greatest opportunity to improve safety.

Normal Driving Conditions

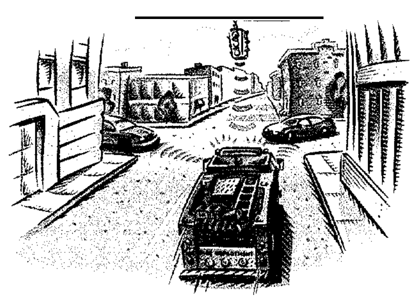


To increase safety under normal driving conditions, the IVI Program encourages the design of in-vehicle communications and information systems that drivers can operate without distraction.

Degraded Driving Conditions

To increase safety in conditions where the risk of a crash is increased, the IVI Program encourages accelerated commercialization of driver warning systems. Examples of degraded driving conditions include reduced visibility, driver fatigue, or narrow lanes.

Imminent Crash Situations



To prevent crashes in dangerous situations where they otherwise would occur, IVI encourages accelerated commercialization of crash avoidance systems.

quickly. Objectives of the Federal program are to:

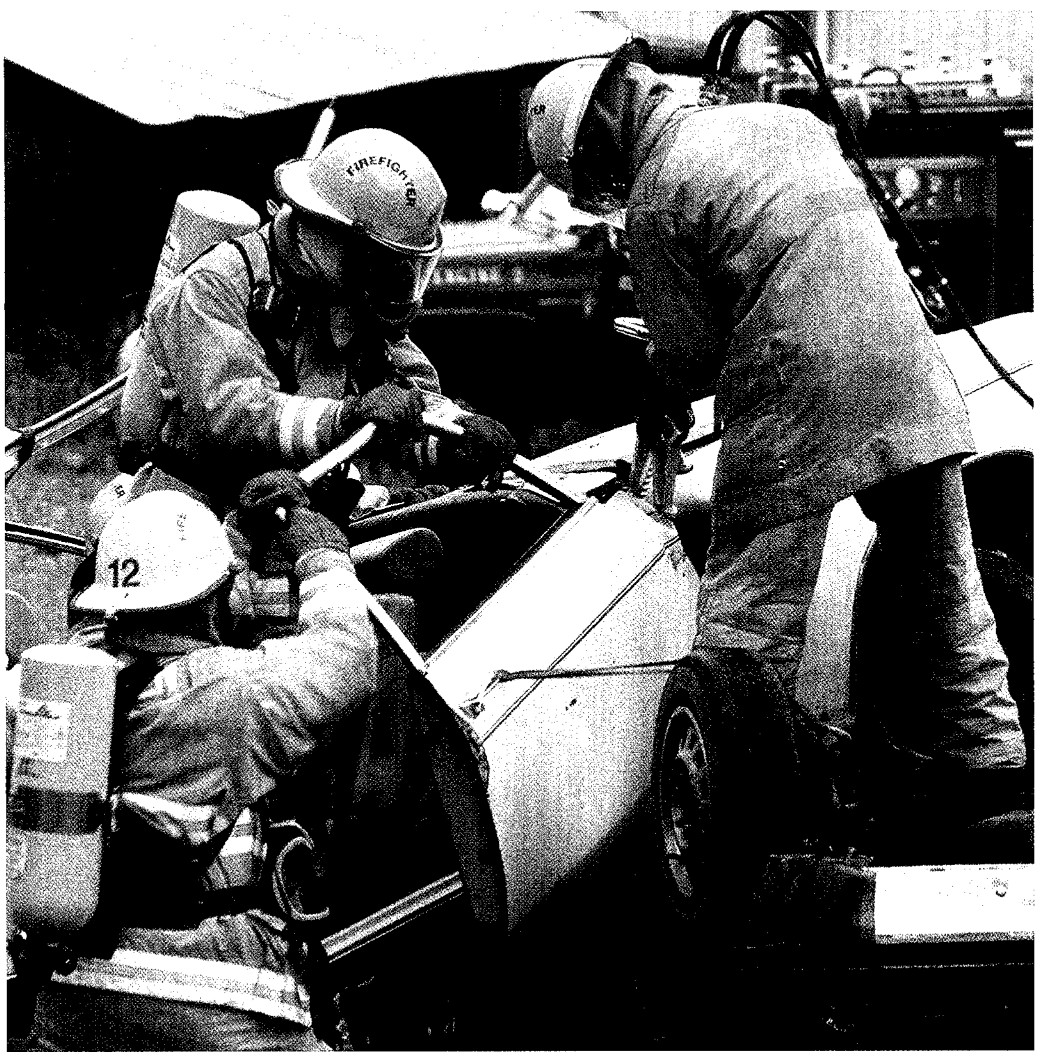
- Define safety system performance requirements;
- Evaluate safety system effectiveness; and
- Encourage the market availability of effective IVI safety systems and services.

The IVI program facilitates the development of crash avoidance systems by identifying promising opportunities to help drivers avoid crashes; demonstrating the feasibility of proposed technology solutions; and evaluating the practicality of technologies on real roads with real drivers.

Partners Contribute More than $40 Million

Public-Private Partners are contributing over $40 million to the IVI program through cooperative agreements with DOT Because the motor vehicle industry ultimately will develop and deploy IVI safety systems in standard vehicle product lines, industry is a key IVI partner. Original equipment manufacturers (OEMs) producing light, commercial transit and specialty vehicles, automotive suppliers, and private fleet operators participate. Public sector partners, including State and local government agencies, public fleet operators, universities, and associations, also are important stakeholders who will play a vital role in deployment of IVI services.

Four DOT agencies participate in IVI: the Federal Highway Administration (FHWA); the Federal Motor Carrier Safety Administration (FMCSA), the Federal Transit Administration (FTA), and the National Highway Traffic Safety Administration (NHTSA). The DOT's ITS Joint Program Office coordinates the IVI.



IVI Program Funding

TEA-21, DOT's authorization legislation, is the principal source for IVI program funding. Among the priority areas for research and development called out in Section 5207 of the legislation are:

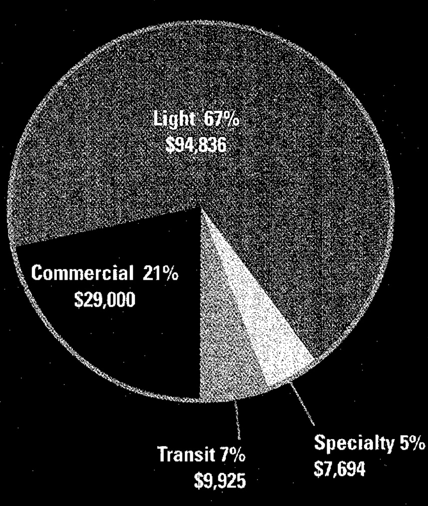
- crash-avoidance technologies, and
- integration of intelligent technologies to link infrastructure, vehicles, and traffic control devices.

The legislation calls for cost-sharing of operational tests and demonstration of these technologies, with the Federal share not to exceed 80 percent.

The pie chart in Figure 1 at right depicts the total funds obligated under IVI for each platform area since fiscal year 1998.

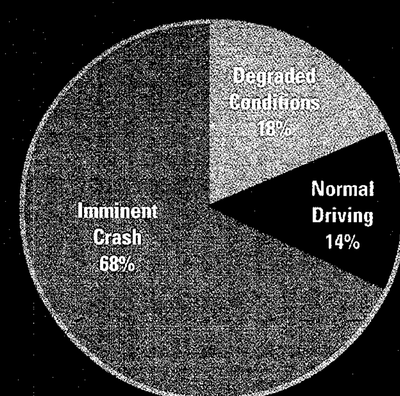
Across the four vehicle platforms, the IVI budget allocation was divided among seven IVI problem areas, as shown in Figure 2.

**Fig. 1.
Program Funding by
Platform (1998-2003)**



Normal Driving	14%
Degraded Driving	18%
Vision enhancement	2%
Vehicle stability	10%
Driver condition	6%
Imminent Crash	68%
Rear end	30%
Road departure	19%
Intersection	12%
Lane change/merge	7%

**Fig. 2.
Program Funding
(1998-2003)**



2002 Progress & Accomplishments

2002 was a year of achievement and transition for the Intelligent Vehicle Initiative (IVI). Collision avoidance technologies for the light vehicle platform progressed to the field operational test (FOT) stage. A landmark event occurred in March 2003, when General Motors and a group of partners launched a major field trial of both forward collision warning and adaptive cruise control systems for passenger cars-emerging technologies that show great promise for reduction of rear-end crashes.

At the same time, FOTs of collision avoidance technologies for commercial and specialty vehicles were completed or winding down. Freightliner's Rollover Stability Advisory and Controller was launched commercially in 2002, following completion of a successful FOT. Volvo trucks and US Xpress, a motor carrier, field tested a rear-end collision warning system that includes adaptive cruise control and advanced braking, and found that most drivers who tried the technology thought it could be useful.

Field tests of frontal and side impact collision warning systems for transit vehicles were successfully completed, and development of an integrated second-generation system that combines both technologies was begun. Afield test of a rear-impact collision warning system was started.

Human factors research to assure the safety of in-vehicle information systems remains a top priority. In 2002 Virginia Tech Transportation Institute (VTTI) initiated the largest instrumented vehicle study ever attempted, in order to study how drivers react under real-world circumstances to competing demands on their attention inside their own vehicles.

Safety of In-Vehicle Information Systems

Ninety percent of crashes are caused by human error, and driver distraction is a key factor leading to driving mistakes. One of the primary goals of the IVI is to ensure that the introduction of in-vehicle technologies-such as cell phones, navigation systems, and on-board computers that deliver Internet-based information-do not increase driver distraction and adversely affect safety. IVI research investigations of the implications of in-vehicle technologies on driver behavior are designed to:

- Improve understanding of the nature and extent of the safety issues;
- Develop and apply methods for assessment of the effects of technology and driver characteristics on driving performance;
- Develop human factors guidelines to aid in equipment design; and

One of the primary goals of the IVI is to ensure that the introduction of in-vehicle technologies does not increase driver distraction and adversely affect safety.

- Develop integrated approaches to reduce distraction from in-vehicle devices.

Highlights of this year's progress related to driver distraction issues are presented below.

VTTI Naturalistic Driving Study

In October 2002, Virginia Tech Transportation Institute (VTTI) began studying how drivers react to competing demands on their attention inside their own vehicles. By March 2003 more than 100 cars belonging to volunteer drivers had been instrumented and were on the road, providing VTTI researchers with detailed information about reactions to various driving situations. Following this one-year pilot study, broader research involving thousands of instrumented vehicles is being planned in cooperation with industry and transportation agencies.

The study is the largest instrumented vehicle study ever attempted, and is expected to provide a wealth of new information about pre-crash behaviors of drivers, which will enable researchers to understand, and eventually to reduce, vehicle crashes.

Veridian Engineering and the University of Michigan Transportation Research Institute (UMTRI) also are participating in this project, which is scheduled for completion in September 2004.

Crash Avoidance Metrics Partnership

The Crash Avoidance Metrics Partnership (CAMP) IVI Light Vehicle Enabling Research Program brings together DaimlerChrysler Research and North America Technology (DaimlerChrysler RTNA); Ford Motor Company (Ford); General Motors Corporation (GM); Navigation Technologies Corporation (Nav/Tech); Nissan Technical Center North America, Inc. (NTCNA); and Toyota Technical Center Inc. USA (TTC) to work with DOT on a set of pre-competitive projects addressing emerging crash avoidance and driver information systems. BMW and Volkswagen joined CAMP in 2002 to work on a new project that focuses on vehicle safety communications.

- *Driver Workload Metrics:* Ford, GM, NTCNA and TTC are developing performance metrics and test procedures for assessment of the visual, manual and cognitive impacts of telematics systems on driver workload. Original Equipment Manufacturers (OEMs) will use these tools to determine whether specific in-vehicle tasks should be accessible to a driver while the vehicle is in motion. Following completion of an initial *Review of Measures, Methods, Models and Metrics for Device-Related Driver Workload Assessment,* work in 2002 focused on development of practical and reliable workload metrics. After the draft metrics are delivered in mid-2003, they will be validated and documented. The VIRTTEX driving simulator at Ford's Scientific Research Laboratory in Dearborn, Michigan will serve as an initial test stage. Ford's proving grounds and the public roads in the surrounding area also will be used to pilot test the validity of the metrics, designed to predict whether various tasks are likely to produce high, moderate, or low "interference" with driving. The project began in April 2001 and is scheduled for completion in April 2004.

- *Enhanced Digital Maps:* DaimlerChrysler RTNA, Ford, GM, NavTech and TTC are cooperating in a feasibility study of improving digital maps to support collision avoidance systems. The results of this effort will provide direction to map suppliers regarding enhancements needed, and establish the preliminary feasibility of generating and maintaining these enhancements.

The Enhanced Digital Maps project has identified 61 potential safety-related vehicle applications that might be enabled or enhanced by improved digital maps. These applications were classified into categories of assistance, warning, and control, and grouped by their potential deployment time frame. Twelve potential applications with the greatest safety potential were selected. Near-term applications are supportable based on road-level mapping. Mid- and long-term applications require lane-level information. Differential Global Positioning System (GPS) technologies are required to support the selected mid-term applications. The project team has learned that current Department of Defense (DoD) research to lower the cost and improve the accuracy of Internal Measurement Unit (IMU) technology could accelerate the development of enhanced digital mapping technology, and is taking steps to obtain the necessary permissions to use these research results.

For the near-term applications, next steps are to develop prototype enhanced digital map systems in a demonstration vehicle.

Forward Collision Warning Requirements: Building on the results of CAMP research completed in 1999, the Forward Collision Warning Requirements project continues to explore how real drivers will react to sudden warnings triggered by collision warning systems. The earlier research determined that drivers prefer alarm clock-like warnings to recorded voices, and that even last-second warnings can give drivers enough time to break or perhaps even steer around a vehicle ahead of them.

But many questions remain. Will drivers respond differently in different weather or light conditions? The earlier research was conducted during clear weather daylight conditions on a straight, dry, level road. The current tests examine additional factors such as time of day, number of alert stages, differences in speed and deceleration of the vehicle ahead, and "last second" lane-change (steering rather than braking) maneuvers.

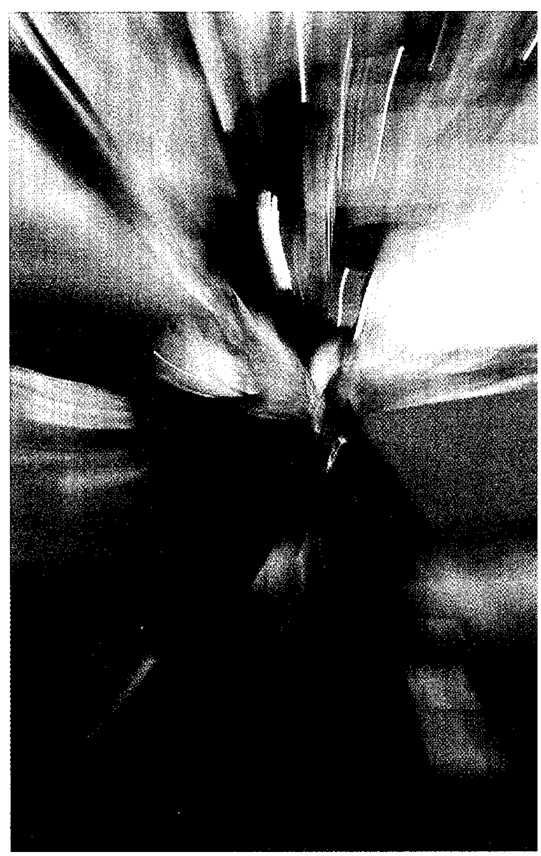
Vehicle Safety Communications Project: Many future vehicle safety technologies will require very low latency communications between vehicles or between a vehicle and the roadway. The capabilities of Dedicated Short Range Communications (DSRC) appear to be unequalled by other anticipated wireless technologies. A new two-year CAMP project on Vehicle Safety Communications (VSC) began in 2002 to explore DSRC issues. Daimler Chrysler, GM, TTC, Ford, Volkswagen, and BMW are participating.

The objective of the VSC program is to facilitate the expedited deployment of advanced driver assistance safety systems by identifying and evaluating communications-enabled safety applications. Influencing the developing 5.9 GHzDSRC standards to support vehicle safety applications is an important goal.

Driver Distraction and Workload Studies

Commercial Vehicle Driver Distraction Workload: Even before the addition of advanced safety features, the cabs of 21st century commercial trucks contain an amazing array of technology. A IO-month project initiated in September 2002 will provide a greater understanding of how truck driver response to in-vehicle technology may differ from the responses of drivers of light vehicles. The study will analyze the human factors requirements of the any devices in a commercial vehicle cab and identify research needed to develop specifications and guidelines to minimize truck driver distraction and workload.

Multiple Collision Alarm Interference: Some impending crash situations, such as a chain-reaction front- and rear-end highway crash, would trigger multiple alarms from crash warning systems. How can these systems be designed to minimize driver confusion? A new study will use a driving simulator to measure driver reaction to multiple colli-



sion alarms, and explore the comparative effectiveness of various designs for alerts and icons.

In-Vehicle Icon Development Process: Icons provide a number of advantages over a text-only approach to presenting drivers with in-vehicle messages-they can be recognized more quickly and accurately than text-only messages; they can be presented in a much smaller area; and they can convey information across many languages and cultures. However, poorly designed icons can confuse drivers and cause errors that exacerbate existing traffic problems.

In 2002, the Battelle Human Factors Transportation Center delivered guidelines for development of in-vehicle icons. The guidelines emphasize general effectiveness, recognition, and comprehension. The development of the guidelines and other deliverables was guided by a project working group comprised of over 30 representatives from the icon design, intelligent transportation systems (ITS), and human factors communities.

511 and Driver Distraction: The Federal Communications Commission (FCC) designated 511 as the national traveler information number in July 2000, and by the end of 2002 more than a dozen 511 systems were operating across the country. A draft white paper on human factors issues related to driver distraction using a 511 system was completed in 2002. The paper provides comments and observations concerning the attention demands of the voice interface used for listening to traffic messages. Research issues related to this 511 voice interface will be incorporated into the planned Virginia Transportation Research Center (VTRC) study of voice interface design parameters.

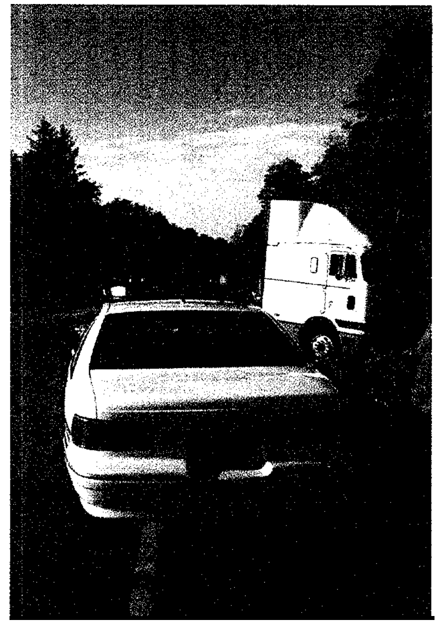
Technology to Improve Driver Performance In Degraded Driving Conditions

Reduced visibility, inclement weather, driver fatigue, poor roadway design, and other degraded driving conditions increase the likelihood of crashes. Work is now underway to demonstrate and evaluate new technologies to improve the drivers perception of the driving environment and the drivers perception of his or her own physical condition, in order to reduce the probability of a crash.

Driver Condition Monitoring

Commercial Vehicle Driver Fatigue Management: NHTSA estimates that approximately 100,000 crashes are caused primarily by driver fatigue, and the issue is particularly acute in the commercial vehicle environment. Driver fatigue is a factor in 18 percent of single-vehicle, large-truck fatal crashes, and in 3 to 6 percent of all fatal crashes involving large trucks.

In February 2002 a Congressionally-mandated pilot test was launched to demonstrate the use of fatigue-management technologies for commercial motor vehicles. The project is a cooperative research initiative between DOT's Federal Motor

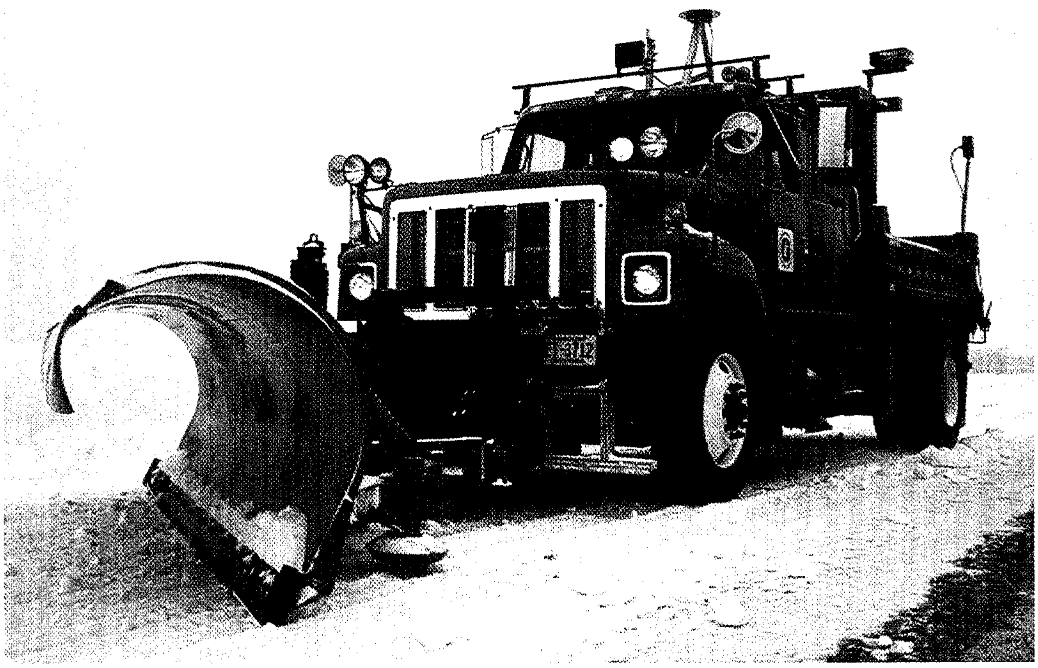


Carrier Safety Administration and Transport Canada, and is being conducted by the American Trucking Associations and the Transportation Research Institute. This pilot test combines driver alertness monitoring (using the eyelid droop measure known as PERCLOS), a sleep history monitoring device (Actigraph), an embedded sleep-wakefulness model, a lane tracking device, and a steering assist system. The technology was initially tested on four vehicles bytwenty-four Canadian drivers, and will also be tested in various locations in the United States. The final report, due in September 2003, will document the evaluation of the drowsy driver interventions and countermeasures.

Vision Enhancement

Reduced visibility is a factor in 42 percent of all vehicle crashes. DOT research contributed to the accelerated commercial deployment of Night Vision ™ technology that was introduced in the 2000 Cadillac DeVille, and is now available on other GM models.

In the winter of 2001-2002, another promising military vision enhancement technology was field-tested with support from IVI: the "Head-Up Display (HUD)," a technology developed for military jet aircraft. The HUD projects a visual display on the drivers field of view that depicts road boundaries and any obstacles in the vehicle's path, based on a geospatial database and radar obstacle sensing. IVI-supported projects currently are exploring use of HUD in specialty and transit vehicles.



Four *snowplows* were *equipped* with Driver Assist Systems for a Minnesota field test.

Minnesota Specialty Vehicle Initiative: Blowing and drifting snow is one of the most dangerous low-visibility driving situations. Drivers of emergency vehicles such as snowplows, law enforcement vehicles, and ambulances must routinely navigate icy roads in blowing and drifting snow while trying to avoid moving and parked cars, bridge end treatments, signs, guardrails, and any number of other difficult-to-see obstacles.

The University of Minnesota's Intelligent Transportation Systems Institute has completed a Field Operational Test (FOT) of a Driver Assist System (DAS) installed in four snowplows, one state highway patrol vehicle, and one ambulance. DAS components included:

- ***Vehicle positioning technologies***
  - differential global positioning system;
  - geospatial database system; and
  - roadway magnetic tape/sensor system.
- ***Collision avoidance technologies***
  - forward-looking radar/forward collision avoidance;
  - side-looking radar/side collision avoidance.
- ***Driver interface***
  - ***Head-Up Device (HUD)***

Feedback from the drivers was quite positive, but unfortunately data from the FOT are insufficientto demonstrate the capacity of the system, because it took place in the winter of 2001-2002, one of the mildest on record in Minnesota, with only two snow events. MNDOT extended the FOT to the winter of 2002-2003 in order to further test these promising technologies under more conducive FOT conditions. Results are currently being analyzed.

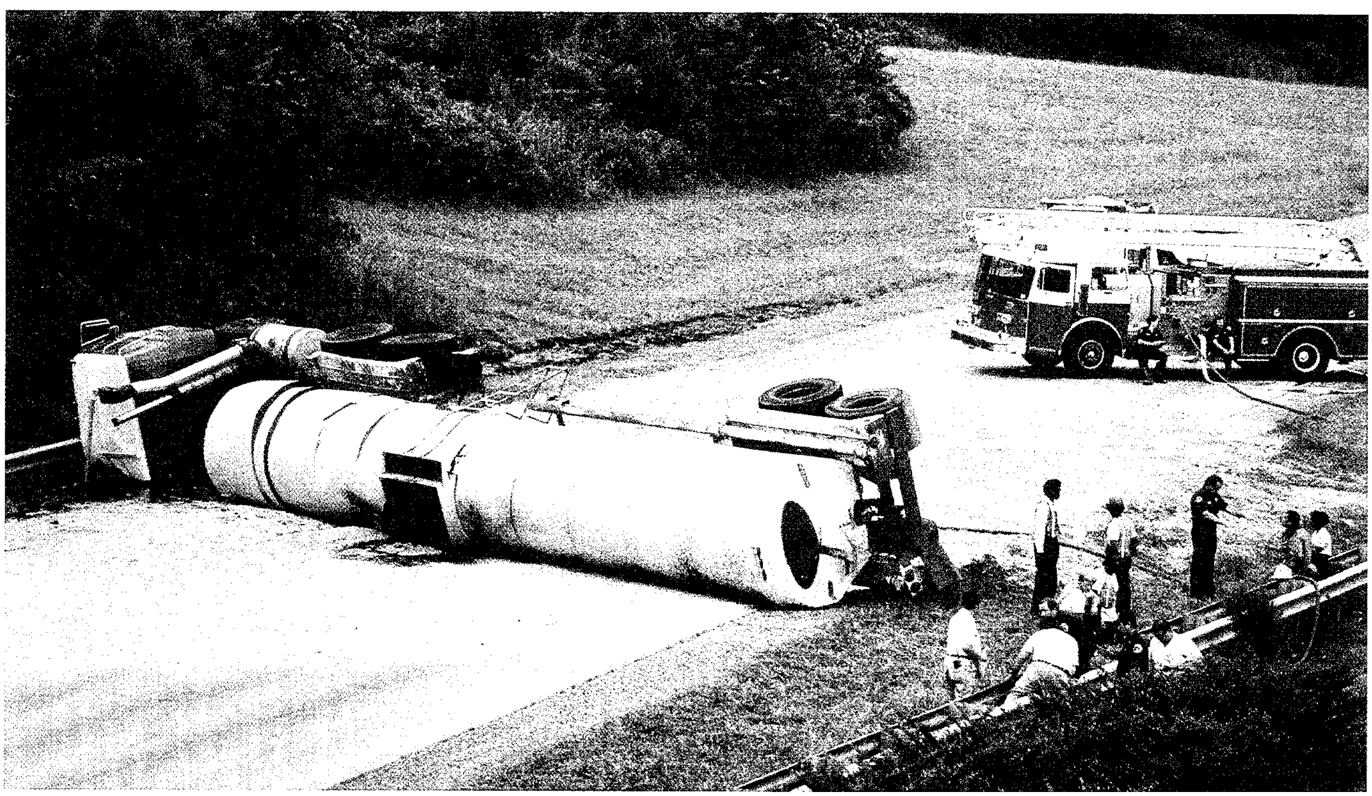
Vehicle Lane-Assist Technology for Bus Rapid Transit (BRT): Lane-assist technology can make it easier for drivers of Bus Rapid Transit (BRT) vehicles to operate safely in narrow lanes, at the desired higher operating speeds. The University of Minnesota and Metro Transit, the transit property in Minneapolis, are analyzing requirements for lane assist systems, and assessing technologies available to satisfy the desired requirements. The project also includes a human factors study of the impact on operators of lane assist systems. The project will culminate in a specification for lane assist systems, to be released in 2003.

*Freightliner **Corporation and Praxair, Inc. completed successful field** tesfs of a **Rollover Stability** Adwisor and **Controller** System, **which** is now on fhe market.*

Vehicle Stability

Rollover crashes accountfor 14 percent of fatal crashes and 9 percent of injury crashes. The hazard is particularly acute for commercial vehicles. Rollovers account for about half of driver fatalities when large trucks crash.

■ ***Commercial Vehicle Rollover Stability System:*** 2002 brought the successful conclusion of a field operational test (FOT) of the Rollover Stability Advisory and Controller (RSA/C) system developed by Freightliner. The system warns the driver when the vehicle is at risk of rollover, and indicates the level of risk, ranging from moderate to severe. The RSA/C system was tested on six commercial vehicles by Praxair Inc., a motor carrier that employs highly skilled and experienced drivers. Nineteen drivers participated in the FOT, and the drivers and their fleet managers reported that they thought the system was acceptable and would be especially beneficial for inexperienced drivers. The researchers concluded that the system provides a small but statisti-



cally significant improvement in aiding the drivers. Freightliner is currently offering the RSA/C system commercially, and Praxair has ordered additional RSA/C-equipped vehicles.

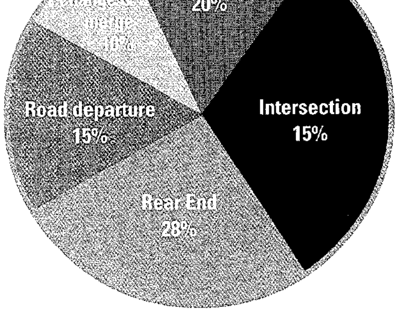
A next step will be to integrate the RSA/C with roadway geometry mapping to make the system more effective as a proactive crash warning/ crash avoidance system.

■ *Commercial Vehicle Lane Guidance:* The Freightliner FOT also demonstrated effective performance of a lane guidance system. The researchers concluded that the lane guidance system performs best when the driver is potentially least attentive.. .during the night and early morning hours, with cruise control engaged at highway speeds, during dry conditions.

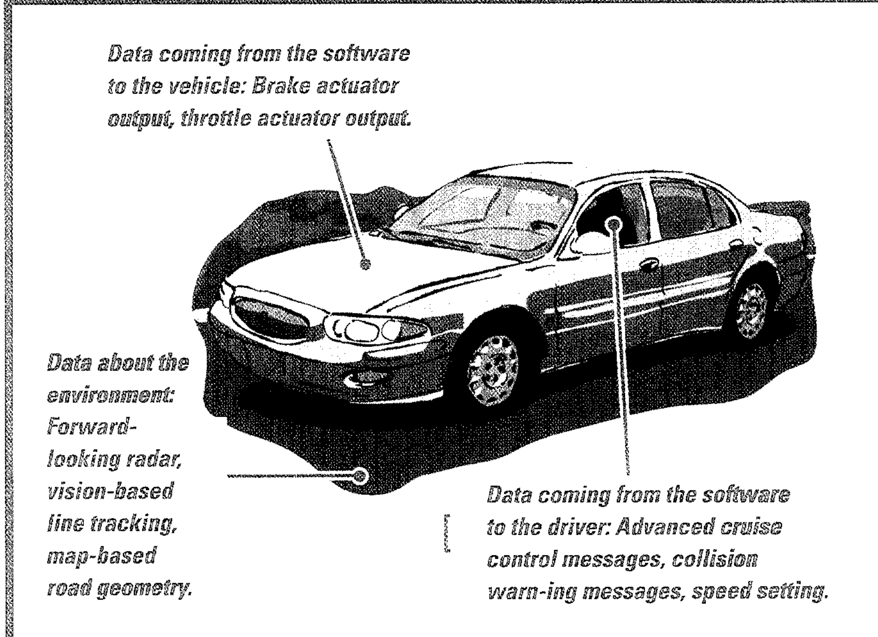
Crash-Avoidance Technology

As Figure 3 shows, four types of collisions account for nearly 80 percent of highway crashes: (1) rear-end collisions; (2) intersection collisions; (3) road departure collisions; and (4) lane change and merge collisions. The IVI program has identified promising approaches for prevention of imminent crashes through safety technologies that provide timely driver assistance, or even assume control of the vehicle.

Fig. 3.
Distribution of Crash Types



The advanced adaptive cruise control/forward collision warning system being developed by GM gathers information—data about the car's functions and movement, the driving environment, and the driver's activities—and adds it up to determine the ongoing threat of a collision. It responds to threats by sounding alerts or altering the car's cruise control speed.



In March 2003, GM began field tests of 10 Buick LaSabres equipped with forward collision warning and adaptive cruise control.

Light Vehicle Collision Warning Systems

■ *Passenger Cars: Rear-End Collision Warning and Adaptive Cruise Control:* In March 2003 General Motors and a group of partners began field tests of 10 Buick LaSabres equipped with both forward collision warning and adaptive cruise control systems-emerging technologies that could help reduce rear-end crashes.

DOT, GM, and Delphi Automotive are funding the project, and UMTRI is under contract to conduct the IO-month field test.

The forward collision warning system uses electronic sensors, global positioning system technology and radar to provide audio and visual warnings to a driver who is approaching a slowed or stopped object too rapidly, or who is following a vehicle too closely. The warning signals the driver that he may need to brake quickly or make an evasive maneuver to avoid a collision. The visual warnings are illuminated in front of the driver on a head-up display (HUD) on the windshield.

Researchers will assess whether drivers experience fewer "close following" or "rapid-closing" driving situations that could lead to crashes, and if the performance of these systems meets consumer expectations.

Adaptive cruise control greatly expands the convenience of cruise control, especially in traffic. The system uses the same sensors as the forward collision warning system, including the radar sensor mounted at the front of the car to detect objects in its path.

If the lane ahead is clear, the system will maintain the set speed, just like conventional cruise control. When a vehicle is detected in same lane in front of the car, the system will adjust vehicle speed by applying limited breaking or acceleration to maintain a driver-selected follow distance to the vehicle ahead.

■ *Passenger Cars: Road Departure Collision Avoidance Systems:* About 15 percent of crashes are single-vehicle road departure crashes, caused by driver inattention, fatigue, or excessive speed, particularly when excessive speed is maintained while negotiating hazardous curves. (Three percent of curves account for 35 percent of curve-related crashes.) Road departure crashes account for approximately 1.2 million police-reported crashes each year.

DOT is partnering with UMTRI, Visteon Corporation, and AssistWare Technology, Inc. in an FOT of a system designed to help drivers avoid road departure crashes. The system warns drivers when they are about to drift off the road and crash into an obstacle, or when they are traveling too fast for an upcoming curve. Technologies include a vision- and radar-based lateral drift warning system and a map-based curve-speed warning system.

Transit Vehicle Collision Warning Systems

■ *Frontal Collision Warning System:* The transit property in San Mateo, California (SamTrans), in partnership with the California Department of Transportation (Caltrans), PATH, and Gillig Corporation, completed initial analysis of a driver-vehicle interface for a system that warns transit bus drivers of an impending collision with the vehicle ahead. The analysis found that the system has achieved the objective of providing warning without unduly interfering with the primary driving task. The prototype collision warning system used sensors (e.g. radar systems, ultrasonic sensors, and laser range finders) to detect obstacles and various software to determine the threat level and generate warnings. The final deliverable from the project will be technical specifications for the frontal collision warning system.

■ *Side Collision Warning System:* Performance specifications were released in May 2002 for a side collision warning system field-tested on transit buses in Pittsburgh. Seventy percent of the drivers who participated in the field test of 100 transit

(Top) Bus passengers in Las Vegas are able to board buses more safely and quickly thanks to the precision docking system used on buses owned by the Regional Transportation Commission of Southern Nevada. (Bottom) Video guidance systems assist bus drivers in handling narrow lanes and other hazardous driving conditions. The system above is tracking a paint stripe.

buses equipped with ultrasonic sensors responded favorably to the technology. Partners included the Port Authority of Allegheny County, Carnegie Mellon University, the Pennsylvania Department of Transportation, and Collision Avoidance Systems.

Integrated Collision Warning System: In order to minimize driver distraction, bus operators should interact with a common interface when being warned of possible frontal and/or side collisions. In a new project launched in April 2002, the forward- and side- collision warning systems will be integrated in order to attain a second-generation, integrated system more suited for commercial deployment.

Rear Impact Collision Warning System: The Ann Arbor Transportation Authority in Michigan and Veridian Engineering began field testing a rear-impact collision warning system for transit buses in the fall of 2002. The system uses radar to sense the imminent crash and attempt to alert the violating driver with a flashing warning.

Commercial and Specialty Vehicle Collision Warning Systems

Volvo trucks and US Xpress will complete field testing of a rear-end collision warning system that includes adaptive cruise control and advanced braking in June 2003. The systems were installed in 100 new trucks. Driver interviews concluded that most drivers had a positive attitude toward the technology but the design of the user interface must be adjusted to better accommodate driver comfort and needs. Technology acceptance seems to increase with use. Evaluation of this project is scheduled for completion in December 2003.

Volvo trucks and US Xpress will complete field testing of a rear-end collision warning system that includes adapative cruise control and advanced braking in June 2003.

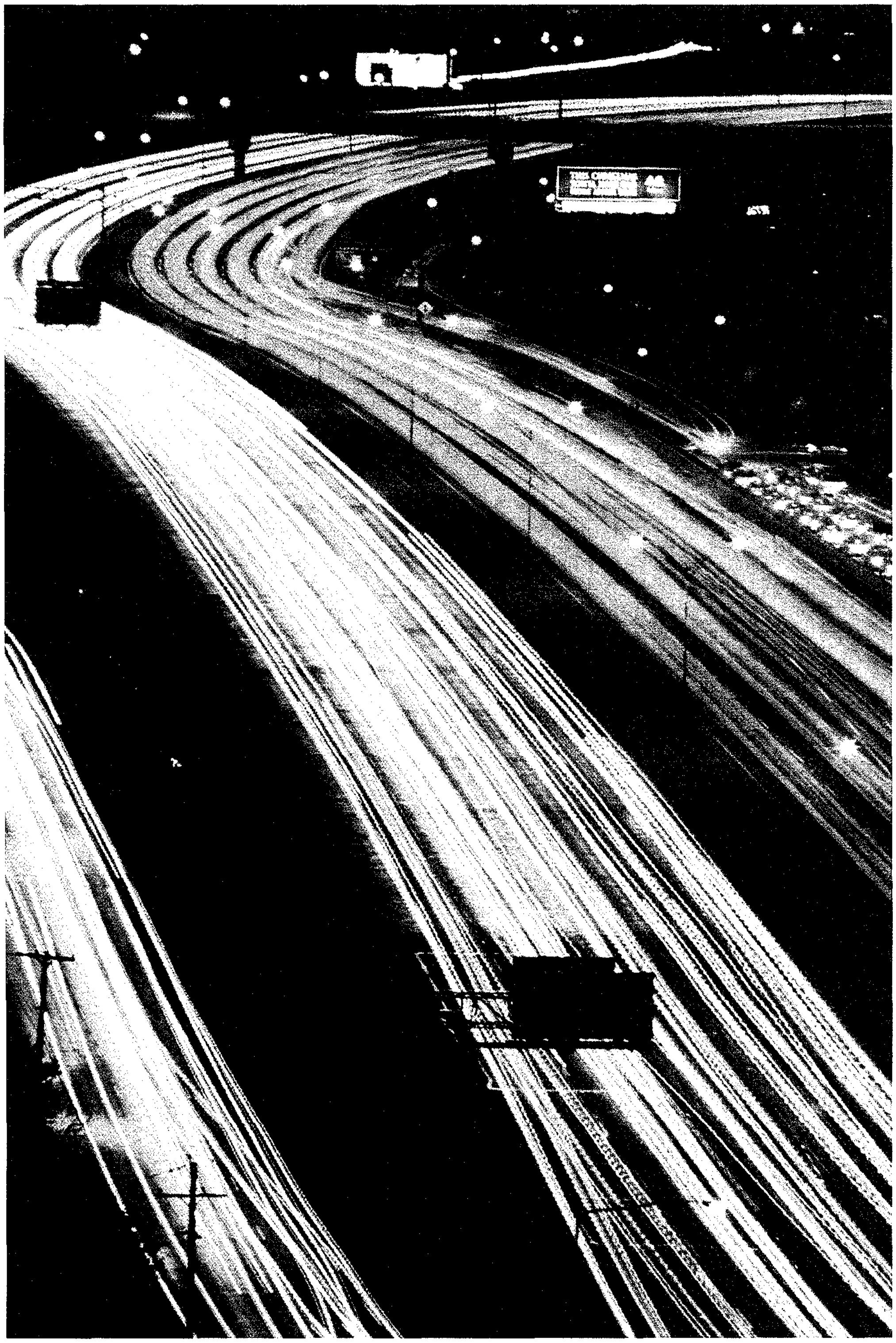
Electronically Controlled Braking Systems: A test track evaluation of electronically controlled braking systems (ECBS) was completed in the fall of 2002. A follow-on project will performance test ECBS systems from three brake manufacturers under normal and failure-mode conditions.

Long-Term Research: Intersection Collision Avoidance Technology

Intersections are among the most dangerous locations on U.S. roads, accounting for approximately 1.9 million police-reported crashes each year. Intersection collisions are complex problems. Long-term research in the IVI program is focused on intersection collision avoidance systems, which would require technology in the vehicle to interact with technology in the infrastructure (for example, roadway sensors and traffic control device timers).

IVI Infrastructure Consortium: The Infrastructure Consortium is a partnership among the California, Minnesota, and Virginia Departments of Transportation; California PATH; the University of Minnesota; and Virginia Polytechnic and State University. In a project begun in 2002, the consortium will develop prototype intersection collision avoidance systems that may be considered for future field operational tests. Three prototype infrastructure-based technologies are scheduled for demonstration at the in June 2003, to be integrated with vehicle-based technologies later in the research program. The Infrastructure Consortium's cooperative agreement with DOT is scheduled for completion in January 2005.

Looking Down the Road



"Deploying safer systems sooner" succinctly summarizes the Intelligent Vehicle Initiative's (M's) overriding objective. IVI partnerships enable vehicle manufacturers and fleet owners to put new safety technologies on the road more quickly, where they can save lives that otherwise would be lost. The Nation's investments in the IVI will bear fruit very quickly.

The systems evaluated under the first IVI field evaluation tests (FOTs) are on the market already-their deployment having been hastened by the DOT support. These include the Freightliner rollover stability advisor/ controller, and adaptive braking systems for heavy trucks.

The first IVI systems are now available on light vehicles. Adaptive cruise control is offered in several makes and models in the United States. Active lane keeping may become available in the next 12 months. Night vision systems have been available for several years.

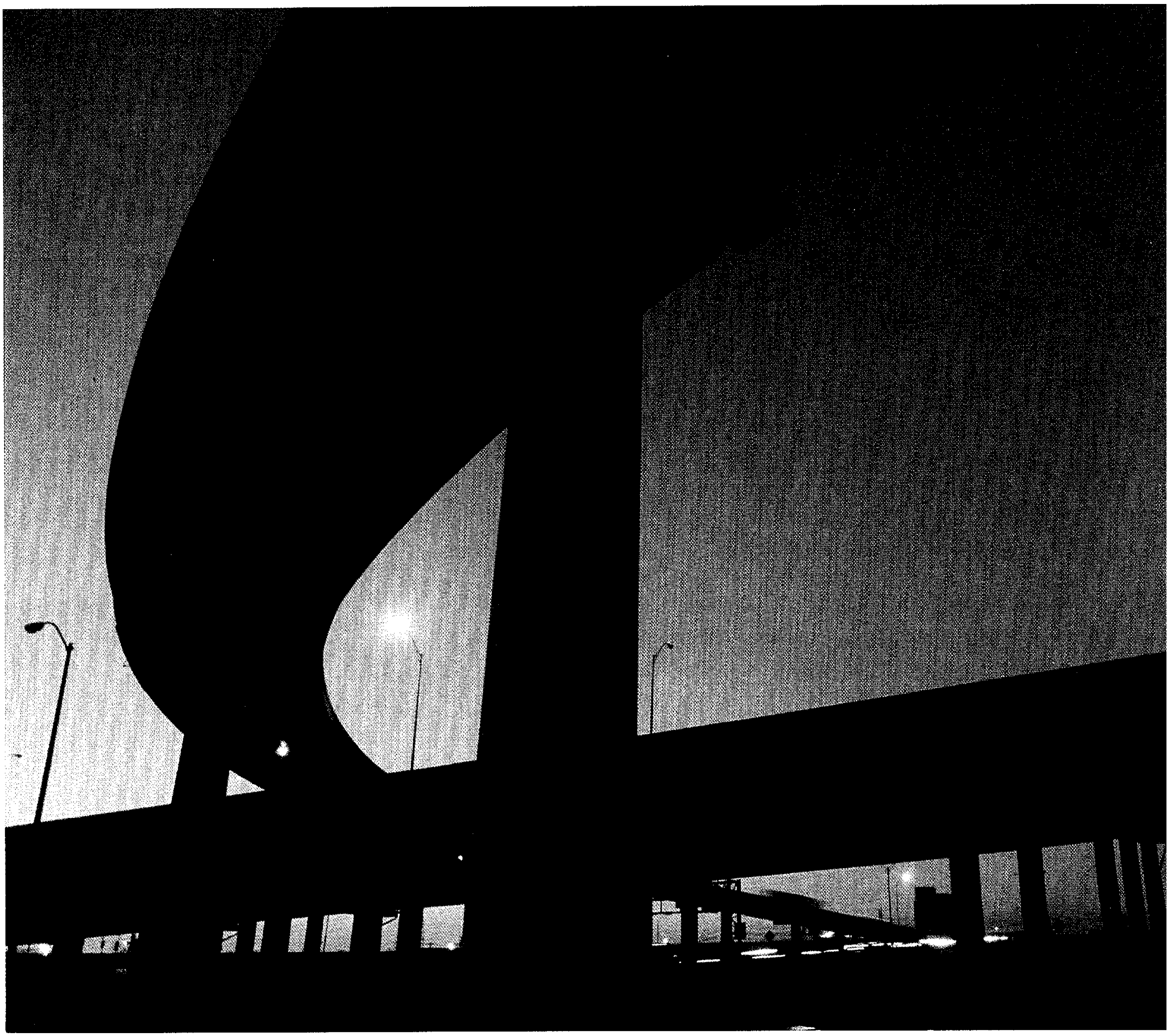
Our expectation is that the results of the rear-end crash avoidance and road departure crash avoidance FOTs will accelerate the availability of these systems on light vehicles, bringing them to market within the next two to three years.

The progress that we are making on vehicle based systems is being complemented by progress in cooperative vehicle highway systems.

The FCC approval of 5.9 GHz for dedicated short range communications provides the critical link needed for sharing information between vehicles and the roadway. The first safety application will be demonstrated for an intersection collision warning system in 2003. Cooperative systems promise to offer improvements in performance of vehicle-based systems by sharing information between vehicle and the roadway.

USDOT will continue driver behavior research to help manufacturers design safer in-vehicle systems to ensure that the new safety technologies introduced in the vehicles on American roadways will not produce additional driver distraction and driver error.

The evolution of safety systems for American highway vehicles is a continuum, stretching backward to the first horns and headlights, and forward toward technologies that we cannot yet imagine. The IVI partner organizations are proud to contribute to the long legacy of American ingenuity.



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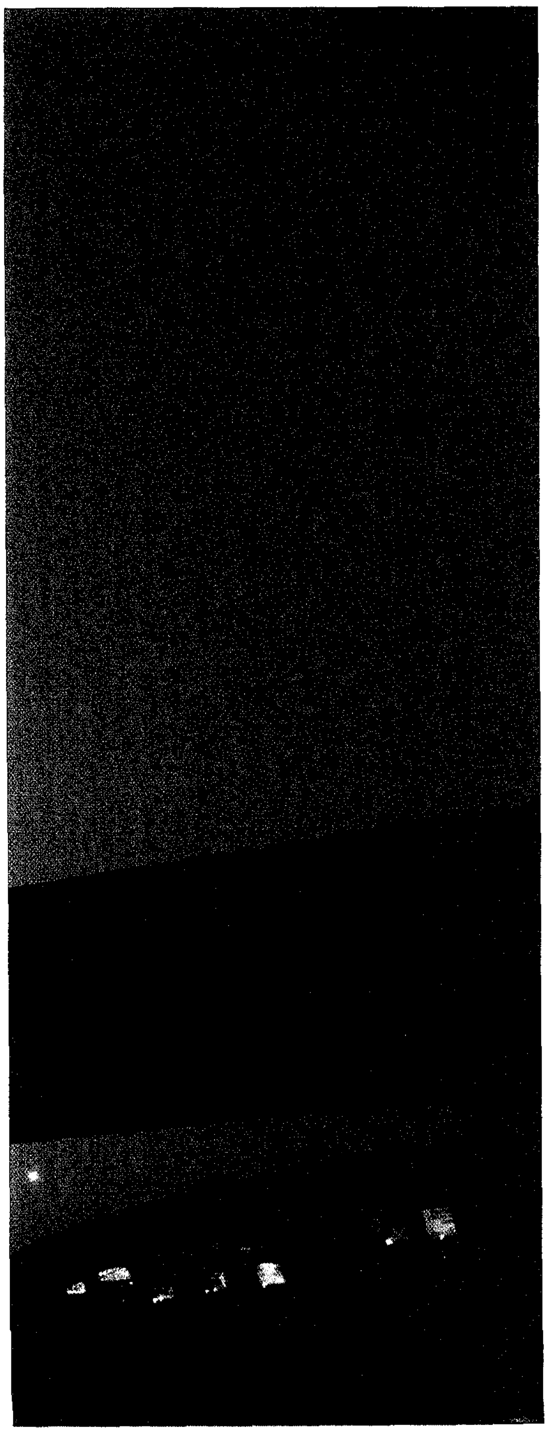

Technical Report Documentation Page

1. Report No. FHWA-OP-03-101	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Intelligent Vehicle Initiative 2002 Annual Report-Saving Lives Through Advanced Vehicle Safety Technology		5. Report Date 5/15/03 6. Performing Organization Code
7. Authors Raymond Resendes and Karen Haas Martin		8. Performing Organization Report No.
9. Pet-forming Organization Name and Address Manifest Inc. DBA Editor's Ink 208 Park Ave. Ste. 611 Gaithersburg, MD 20877		10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Federal Highway Administration U.S. Department of Transportation 400 7th Street SW Room 3416 Washington, DC 20590		13. Type of Report and Period Covered 14. Sponsoring Agency Code 15. HOIT-1

15. Supplementary Notes

16. Abstract

This Annual Report provides an overview of the intelligent Vehicle initiative's (IVI's) progress and accomplishments during 2002. The 1998 Transportation This Annual Report provides an overview of the Intelligent Vehicle Initiative's (IVI's) progress and accomplishments during 2002. The 1998 Transportation Efficiency Act for the 21st Century (TEA-21) authorized IVI as part of the Department of Transportation's (DOT's) Intelligent Transportation Systems (ITS) program. More than 42,000 Americans died as a result of 6.8 million crashes on our Nation's roadways last year. On average, a person was injured in one of these crashes every 10 seconds, and someone was kiiled every 12 minutes, Because driver error remains the leading cause of crashes, cited in more than 90 percent of police crash reports, the IVI's mission is to reduce the number and severity of crashes through driver assistance programs. These safety systems, now in various stages of development, will provide information, warn drivers of dangerous situations, recommend actions, and even assume partial control of vehicles to avoid collisions. Four DOT agencies participate in IVI: the Federal Highway Administration (FHWA); the Federal Motor Carrier Safety Administration (FMCSA), the Federal Transit Administration (FTA), and the National Highway Traffic Safety Administration (NHTSA). The DOT's ITS Joint Program Office coordinates the IVI.

17. Key Words Intelligent Transportation Systems, Intelligent Vehicle Initiative, Traffic Safety, Crash Avoidance, Telematics, Commercial Vehicle, Transit Safety, Driver Distraction	18. Distribution Statement No restriction. This document is available to the public through the National Technical Information Service 5285 Port Royal Road Springfield VA 22161

19. Security Classif.(of this report) Unclassified	19. Security Classif. (of this page) Unclassified	20. No. of Pages	21. Price